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SOME VARIATIONS IN CERTAIN PHASES OF THE BIOLOGY OF *MELANOPHILA CALIFORNICA* VAN DYKE AT HACKAMORE, MODOC COUNTY, CALIFORNIA

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SOME VARIATIONS IN CERTAIN PHASES OF THE BIOLOGY OF *Melanophila californica* Van Dyke AT HACKAMORE, MODOC COUNTY, CALIFORNIA.

INTRODUCTION

During the 1939-1940 field seasons new variations in the biology of the California Flathead Borer, *Melanophila californica* Van Dyke, were observed at the Hackamore Field Laboratory of the Bureau of Entomology and Plant Quarantine. These variations, which appear to be of exceptional occurrence, depart considerably from what has been considered to be the normal biology. For that reason they may be important in indicating some of the modifications that are possible in the life history of the species. The observations are some results of a continuation of the general study of the biology of the species that has been in progress at the Hackamore field laboratory from 1936 to 1939. The results of previous studies have been reported on by several workers (see list of references).

The infested host materials on which these observations were made were selected because they presented examples of atypical brood behavior or atypical brood development with respect to the season of year in which they were found, or they were so treated that atypical brood conditions were created. Thus, for example, trees were sought out and used that contained broods of fastgrowing *Melanophila californica* larvae at a time of the year when the *Melanophila californica* broods were predominantly in an overwintering prepupal condition. Again, green trees infested with incipient larvae were felled in late summer and during the autumn, and the subsequent development of the incipient larvae during the autumn and the succeeding winter and spring was followed. Thus effort was directed particularly towards finding infestations of an exceptional nature so that observations might be made of the constancy of the life history in such cases.

The work here reported was begun in August, 1939, under the direction of Mr. J. M. Miller and the supervision of Dr. K. A. Salman. Through the generous cooperation of the Forest Service officials of the Modoc National Forest, CCC enrollees and equipment from the Hackamore camp were provided to assist in the carrying out of the field program.

OBJECTIVES OF THE STUDY

The purpose of the study was further observation of the rates and course of development of the larvae of *M. californica*, and of the length of the life cycle of the species. Previous study of the biology of the species and of the general sequence of its development in the Modoc area has suggested that it

requires a minimum of two years to complete its life cycle. This interpretation was based on these four general conclusions:

(1) "that M. californica cannot develop without spending at least a year as incipient larvae in green trees" (6d, p.30)
(2) "that fast-growing larvae do not successfully overwinter" (6d, p.21)
(3) "that the prepupal stage is in the nature of an enforced diapause requisite for further growth, and is the normal overwintering stage" (6d, p.5; 6d, p.16)

Flathead infestations of exceptional character were selected and observed in the 1939-1940 study to determine if departures from these general conclusions occurred. The work was planned to answer the following three questions:

(1) are the incipients of the season's hatching able to become fast-growing before spending a year in a green tree, and to develop through to the adult stage in the same manner as associated incipient larvae of previous seasons?
(2) are fast-growing larvae able to pass the winter and complete their development to a prepupal condition in the succeeding spring?
(3) is the prepupal condition one of enforced diapause and must a winter season in that condition be passed before development into the adult stage may occur?

MATERIALS AND METHODS

The materials used in this study may be grouped in five categories on the basis of their origin as follows:

A. two trees with many small fast-growing larvae, and these apparently predominantly of the current season's attack. Such an infestation contrasts with the usual infestations in which the trees contain larval broods representing several years of attack. In the late summer of 1939 two green poles were found to contain many small fast-growing larvae, but with only few recent incipient galleries, and these perhaps with no living larvae at their ends. Thus the brood was predominantly of one year and was in a fast-growing condition at the onset of autumn and winter. These two trees were selected for study, were felled, and logs taken from them for storage overwinter in the insectary and rearing in 1940. (Trees numbered 39-15 and 39-19)

B. two trees with broods of small fast-growing larvae representing cumulative attacks of several years. In the late summer of 1939 two green poles with small fast-growing larvae and numerous incipient galleries were found. Since the occurrence of larval broods in the fast-growing condition in

late summer and autumn is relatively uncommon, (most infested trees containing either incipient larvae or prepupal larvae at this time of the year) these poles were felled and the logs held overwinter at the insectary for observation and rearing in 1940. (Trees numbered 39-16 and 39-17).

C Six immature and mature green trees with infestations of living incipients. These trees were felled in the autumn of 1939, parts of the boles being left in the field and parts taken to the insectary as logs. West (6d, p.44) had found that the felling of trees helped to initiate the fast-growing larval stage. This material, the broods of which were in a condition usual for this time of year, was felled to see if the broods would develop overwinter and thus provide an answer to some of thequestions raised above. (Trees numbered 39-33, 39-34, 39-37, 39-38, 39-41, and 39-42).

D. Five trees containing small fast-growing larvae late in the autumn that were sampled but left standing overwinter in the field. Three additional trees, which in the spring of 1940 appeared to have had fast-growing larvae in them during the previous winter also were added to this series. All of these trees were felled in May, 1940, and analysed for composition of infestation and sections of their bark placed in rearing. (Trees numbered 39-W-1 to 39-W-8 inclusive).

Invalid addition
no proof of condition of larvae in fall of 1939

E. Six trees on Timber Mountain containing overwintering fast-growing larvae in portions of their boles. These trees had been felled in the fall during studies of composition of infestation and, with one exception, were left to lie overwinter in the field instead of being taken to the laboratory for winter storage. (Trees numbered 304, 381, 435, 438, 947, and 1333).

OBSERVATIONS ON SUCCESS OF BROOD DEVELOPMENT IN EXPERIMENTAL MATERIAL

Tables I, IIa, IIb, IIc, and III give in detail the progress and success of brood development in the infested materials as revealed by sampling at various periods. The extent to which broods were able to develop successfully in this material may be important in indicating the effects of the occurrence of certain stages at off seasons upon the potentialities of such broods for successful development. In some cases the behavior of some of the larval populations in this experimental host material raises further problems, solutions to which may be found only by further experimental work.

Group A. One of these poles had suffered a singeing of the lower crown and a killing of the phloem around three-quarters of the circumference of the butt as a result of a 1938 summer ground fire. In spite of this injury the 1939 growth ring in the bole above the injury was as wide as the 1938, and the complement complete except in two segments where the 1933 ring

was missing. The brood in logs from this tree was successful, an average of 8.5 adults of M. californica emerging during 1940 per square foot of bark surface.

The other pole was uninjured. Its growth complement could not be determined because of previous missing rings. In the 1940 rearings it produced 12.3 adult M. californica per square foot of bark. It is evident that the broods in the fast-growing stage continued their development successfully in these poles after the tree had been cut and the logs placed in rearing.

Group B. This material, which contained brood of several years attacks in the fast-growing stage when the trees were felled, also satisfactorily developed the populations to maturity. The emergence during the 1940 season amounted to 11.3 and 12.6 adults of M. californica per square foot of bark surface.

Group C. These trees differed from those in groups A and B in having broods in the incipient stage at the time the trees were felled. And in contrast to the others, also, the success of the broods varied considerably. None of the incipient brood developed successfully to maturity in three of the six trees. In one other the fast-growing stage was not reached until the following spring.

The development of broods in the remaining two trees was entirely different. After the trees were felled in the autumn, the brood developed successfully, even during the mild winter weather, and adults of M. californica emerged in 1940 at the rate of 5.7 and 3.5 per square foot of bark. This difference in the success of development of broods in these trees cannot be traced to any variations in the treatment of the trees, time of cutting, the "lie" of the logs, deterioration of phloem, or differences in the initial brood conditions. This great variation in the success of development of the broods that appeared to be under similar conditions, but in different trees, is not readily explainable.

Group D. Basal examinations of these trees during the autumn and winter revealed that they contained overwintering fast-growing larvae, at least in the base of the bole. The trees were felled in May, 1940, and it was found that the broods in these trees were not uniformly in the same stage of development throughout the bole. Thus there was no ~~certainty~~ evidence that prepupae found late in the spring had necessarily come from overwintering fast-growing larvae. In general the development of these broods was not satisfactory. In the green butts there was a general failure to continue growth in the spring. However, some individuals reached the prepupal stage early in 1940, and adults of M. californica emerged from the bark of six of these eight trees. The emergence was very low in three of these six trees, and, although prepupal larvae remaining in the bark at this time may raise the total emergence figures, it cannot be said that this type of host material and brood produced high populations of adults.

Group E. These Timber Mountain trees were felled in the autumn of 1939, and notes were taken on the condition of the broods at that time. There was considerable variation in the stages of development in different parts of the boles of these trees. For the most part the development of broods in these trees was much more successful than those in Group D, although the chief difference between the two sets of material was that one group was left standing overwinter and the other type was felled. Since two of the trees still contain prepupae, it is possible that more emergence may occur in the spring of 1941.

RESULTS OF THE STUDY

Because of the variety of types of infested materials and the varying extent to which they yielded data upon the problems that were being studied, the discussion of the results becomes somewhat detailed. For this reason it seems advisable to present the data for, and to discuss as separate units, each of three main questions with which the study was concerned.

Question 1. Are the incipients of the season's hatching able to become fast-growing before spending a year in a green tree, and to develop through to the adult stage in the same manner as associated incipient larvae of previous seasons?

The evidence used in answering this question is drawn from two sets of material (Groups A and C). Examination of the pole material (Group A) soon after the trees were felled showed that the older incipients of previous seasons, which were identified by their association with incipient wood galleries, were dead. But in 1940 a heavy emergence of adults occurred. Apparently these had come from the small fast-growing larvae which were so numerous in the poles in late summer of 1939. Since these larvae were not connected with wood-scarring galleries, they probably had developed directly from eggs laid during the 1939 season. However, some prepupal larvae have remained in the bark during the winter of 1940-41, and rearing during the coming season may indicate that a part of this brood has required two years to develop from egg to adult, but without having spent one year as incipients.

In the Group C material, which contained incipients at the time of falling of the trees, fast-growing larvae of brood of mixed ages were obtained in three of the trees. Periodic examinations during the fall of 1939 showed that some individuals, apparently of the 1939 oviposition, developed along with those of other years. But the fast-growing condition tended to appear several days later in the 1939 brood than in the older brood, and for this reason the 1939 larvae were smaller than the others. The degree to which these larvae might overtake and compete successfully with the more advanced larvae of other seasons was not learned, since the observations were made in the earliest stages of the development of the fast-growing larvae.

When making the successive observations and samplings on the Group C material, it was necessary to classify the larvae as incipients or as fast-growing in order to trace the development of the broods. In so doing, the problem was met of deciding when a larva was in an incipient condition and of when it was in a fast-growing condition. Observations of a considerable number of larvae during their ~~progressive~~ development seemed to indicate that the first evidence of change from an incipient to a fast-growing condition was given not by change in size or general appearance, but by difference in behavior. This has been well described by West (6b, pp.7-9). When a change to a more rapid development occurs, the small incipient-size larva begins to mine out in several directions, making the mine much wider than the larva itself and sometimes with several lobes. At the same time crescents of frass accumulate behind the larva. Such behavior contrasts with that of the incipient larva, which mines rather directly forward making a mine scarcely wider than itself and depositing a slender homegeneous thread of frass behind it. These differences in mining habit were used as a basis for determining the developmental condition of the larvae.

Conclusion to question 1.: from a study of the data yielded by the observations of 1939-1940, it would appear that incipient larvae of the season's hatching are able to become fast-growing without spending a year in a green tree, and that they probably are able to develop through to the adult stage in the same manner as associated incipient larvae of previous seasons' attacks.

Question 2.: Are fast-growing larvae able to survive the winter successfully, and to continue their development to a prepupal condition in the succeeding spring?

The evidence used in answering this question is drawn from all of the material studied (Groups A to E). But since the conditions of the larval broods was known best in the materials of the first three groups, these provide the most certain evidence on the problem. Broods in the poles (Groups A and B) were small fast-growing larvae in August, 1939. In all four poles the broods passed the winter in the fast-growing condition. In the late spring of 1940 transformation to prepupae was accomplished, and in June adults of M. californica were produced.

In two of the six trees in Group C incipients became fast-growing larvae and entered the winter period in this condition. By the following March one-half to fully-grown larvae, and some prepupae, were found in logs from these two trees. In a third tree of the same group the first apparent growth of the brood took place in the spring of 1940. In all three the prepupal condition was reached in the spring, followed by emergence in the summer,- that from the third tree being of questionable success, although development through to the adult stage for one individual was recorded.

Material from Group D contained overwintering fast-growing larvae in the lower bole when examined in the late fall, 1939. These trees were allowed to stand over winter, and were felled for stem analyses in May, 1940. They proved to be not very satisfactory, as the larvae were, in most cases, not uniform in their degree of development in different parts of the trees or in the same parts of the trees. Brood developed poorly in some of these trees and, because of the variation in overwintering stages, there was no certainty that the prepupae that were found in late spring had necessarily come from overwintering fast-growing larvae. It does seem probable, however, that a certain amount of successful development of overwintering fast-growing larvae occurred in most of the trees of this group, since prepupae and adults were produced in parts of the trees that contained fast-growing larvae predominantly.

Group F also provides information which is not certain, likewise, because of the lackof uniformity in brood development in the trees. But it seems probable that some of the overwintering larvae were successful in reaching the prepupal, and perhaps even the adult condition; for as in Group D, some prepupae were found in, and adults emerged from, portions of the boles that contained predominantly fast-growing larvae during the winter period. However, emergence from the portions of the trees containing the younger overwintering brood was generally low as compared to the emergence from other parts of the bole in which the larval condition was more advanced before the onset of winter.

Conclusion to Question 2: From direct observation on some specially favorable materials it is evident that larvae in the fast-growing condition at the onset of winter were able to pass the winter successfully and to continue their development to a prepupal condition in the succeeding spring.

Question 3. Is the prepupal condition one of enforced diapause and must a winter season in that condition be passed before development into the adult stage may occur?

The evidence on this question has been suggested in the preceding sections. The most reliable data are furnished by the poles of Groups A and B and the trees of Group C. In the materials of these groups the original condition and subsequent development of the broods is known best. In these materials it is evident that broods which passed the winter as fast-growing larvae were able to continue development through the prepupal condition into the pupal and adult stages without spending many days in each stage. Indications that such a development is possible also is provided by the other classes of material. However, as mentioned before, some larvae that appear to be Melanophila yet remain in the rearing material of all classes, and it is possible that some of the prepupal larvae will have undergone one overwintering before completing their development and emerging as adults.

Conclusion to Question 3: The prepupal condition does not appear to be necessarily one of enforced diapause that must spend one winter before developing into the adult stage. In some individuals it may be, instead, a stage of short duration that may produce adults in the same season of its origin.

ADDITIONAL INFORMATION RESULTING FROM THIS STUDY

The Possibility of a One-year Life Cycle:

From the developmental records of the larvae in the Group A material, it appears that a one-year life cycle is possible. Emergence from some of this material amounted to 8.5 beetles per square foot, while there were only 1.5 recent incipient galleries per square foot in this same material. In addition most or all of the older incipient larvae in the samples examined were found to be dead at the ends of their galleries. Thus probably most of the emergence in the summer of 1940 was from eggs laid during the summer of 1939.

After the emergence of adults in 1940 from the Group A material, the bark was removed from slabs and logs in rearing and the larval mines traced from their inception in the phloem to the pupal cells from which the adults had emerged (Figures 3, 4, and 5). In these it was observed that the larvae had mined from the inner bark down through the phloem to the sapwood and there underwent continuous growth and development to the adult condition without interruption or the intervention of a true incipient stage. The appearance and form of these mines, with their gradual increase in width, resembles those previously attributed to M. gentilis LeConte. They differ markedly from those of fast-growing larvae derived from incipients which have been in the tree for more than one season. Ordinarily such mines widen abruptly beyond the incipient gallery and are not of the same form as the original mine produced when the larva first entered the tree from the bark. Since a complete growth complement was found in one of these trees, it would seem probable that incipient galleries in the sapwood would have been formed if the larvae had had their origin previous to 1939.

Because of such evidence, therefore, it seems only possible to conclude that in the case of the material of Group A an actual one-year life cycle did occur. This is the only case that has been encountered in the several years during which investigations upon the life history of Melanophila californica have been in progress.

Divided Emergence of the Brood:

During previous years examinations of large series of bark specimens from which adults of M. californica had emerged never have revealed the presence of additional brood which would require another year to pass through the prepupal and pupal stages to adulthood. In the material with

which this study is concerned a number of cases exist in which the emergence of the brood of M. californica taking place in the 1940 season appears to have been incomplete. Larvae, apparently in the Genus Melanophila as identified by the characters of Burke's key (1), have remained in the bark and probably will not emerge until next year. One example of divided emergence is indicated in Figure 3, in which a plugged pupal cell at the end of the upper larval gallery was found to contain a living prepupal larva. Another pupal cell that yielded an adult beetle is observable in the same photograph at the end of the lower gallery. This habit, which Secrest (5) has reported occuring in Melanophila fulvoguttata Harr and which DeLeon (2) has reported for M. drummondi Kirby, apparently also occurs under some conditions in M. californica.*

As a check on the occurrence of a divided brood in the off-season trees, the bark of five other trees was placed in rearing in 1940. The broods had gone through the more typical development from a fast-growing condition in early summer of 1939 to a prepupal condition by the end of the summer. Following the emergence period in 1940 the bark was examined for the presence of further undeveloped broods. No prepupal larvae were found remaining in the bark after the emergence period. The emergence of the brood would appear thus to have been completed in the one summer, -this observation being in agreement with previous ones (6d).

Development of Larvae from Incipient Condition to the Adult Stage in One Season.

At best the evidence that such a rapid development is possible is meager and inconclusive. In one tree which had been felled late in the 1939 season the incipient larvae did not appear to assume the fast-growing stage until the spring of 1940. Later in the year, after the general emergence period had passed, the bark from this tree was examined and one dead, fully-developed adult M. californica was found in its pupal cell from which it had failed to escape. In another part of the bole two emergence holes of the type made by M. californica were found. These were connected with pupal cells. However, most of the brood that remained in the bark consisted of living Melanophila prepupal larvae. The observation that development from incipient to adult in one season is possible is inconclusive, in as much as it is entirely possible that some larvae had established a fast-growing condition in 1939 soon after the tree was felled. These could have been missed in the sampling that was made during the autumn, winter, and spring to determine the condition of the brood in the logs.

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* This has been confirmed since the preparation of the manuscript by the emergence of M. californica in April 1941, from material of Group A that produced adults in 1940.

SUMMARY

Description is given of observations made on some specially-selected host materials containing infestations of Melanophila californica Van Dyke. These materials contained off-season or atypical broods of the species and were chosen in order to investigate the constancy of the various phases of its life history. The infestations in the materials were observed repeatedly in order to trace the course of development of the larvae and other stages. Evidence was found indicating that:

(1) at times small larvae of the season may be able to develop into the fast-growing condition and possibly to maturity without having spent a year in the green trees as incipients;

(2) under some conditions, or in certain trees, larvae are able to overwinter in a fast-growing condition and to complete development to a prepupal condition in the succeeding spring;

(3) at times the prepupal stage can be of short duration, and development can proceed to the adult condition from prepupae that have not overwintered;

(4) one tree, or possibly two, contained broods in which development from egg to adult appears to have taken place within one year;

(5) emergence of the brood from a tree may not be complete in one season,- but may take place over two seasons;

(6) it may be possible that development from incipient to the adult can occur within a single growing season,- although the data are inconclusive for this possibility.

These observations indicate what may occur in the development of Melanophila californica under some conditions. Experience has yet to show that such phenomena are frequent and characteristic of a considerable portion of a season's developing flathead population. Present knowledge of the biology of the species has been contributed chiefly from the studies in the vicinity of Hackamore in the Modoc National Forest. But since the species in different parts of its range is subjected to many different climatic and site conditions, further study in other areas might reveal other variations in its seasonal history, or clarify the significance of the variations that have been described in this report.

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Table I — Observations on the Development of Incipients into Fast-growing Larvae*

Tree No.	Date Felled	Date Exam.	Sq. Ft. Exam.	No. 1939 Larvae Living and Dead: Living, inc **	Living f.g.	Dead	No. Older Incipients Living and Dead: Living, inc.**	Living f.g.	Dead
39-15	8-12-39	8-12-39	-----	many	few	-----	none?	none?	-----
		8-16-39	1.85	108	24	9	none	none	3
39-19	8-12-39	8-12-39	-----	----	numerous	-----	none?	none?	-----
		8-15-39	-----	----	many	-----	none	none	all dead
39-33	9-1-39	9-1-39	-----	a few	none	-----	many	none	-----
		9-10-39	1.35	3	none	2	15	3	11
		9-15-39	1.23	1	possibly 1	1	10	3	9
		9-20-39	-----	1	possibly 1	1	5	----	9
		9-21-39	-----	2	possibly 1	3	2	14	37
		9-25-39	-----	2	-----	-----	4	2	6
		10-3-39	-----	4	-----	-----	1	3	8
		10-3-39	.80	3	-----	-----	-----	----	3
39-34	9-1-39	9-1-39	-----	numerous	none	-----	numerous	none	-----
		9-10-39	1.29	3	-----	-----	6	3	-----
		9-15-39	1.26	1	2	-----	4	6	-----
		9-20-39	2.50	3	1	1	1	14	-----
		9-25-39	1.67	2	2	-----	-----	8	1
		9-29-39	4.69	1	7	-----	-----	34	1
		10-2-39	3.46	9	14	-----	-----	22	1
39-38	9-16-39	9-16-39	-----	few	none	-----	numerous	none	-----
		10-3-39	.45	-----	-----	1	1	7	-----
39-37	9-11-39	9-11-39	-----	many	none	-----	numerous	none	-----
		9-21-39	1.88	10	-----	4	7	-----	2
		9-25-39		5	-----	-----	1	-----	-----
		10-28-39		1	2	-----	-----	6	1
		10-3-39	1.96	3	-----	-----	-----	-----	-----
		10-28-39		1	5	-----	1	4	-----
		11-4-39	2.20	17	3	2	5	6	3
		11-20-39	1.97	8	2	-----	-----	3	-----

* The designation "fast-growing" is abbreviated to f.g. in this table.

** inc. - is abbreviation for "incipient" larvae.

Table II, a Observations on the Development of Overwintering Melanophila californica Broods*

Tree No.	Date Felled	1939 Last Observ.	Spec. Notes.	- 1940 Season - March 3rd wk.	May 2nd wk.	June 4th wk.	Adults&emerg.	Oct.-Nov.	Remarks
39-15	8-12-39	inc, small fg	insectary	fg $\frac{1}{4}$-$\frac{1}{2}$	fg $\frac{1}{2}$, pp	-----	105 Mc	pp Melan?	divided brood
39-16	8-15-39	small fg	insectary	fg	fg $\frac{1}{2}$, pp	-----	99 Mc	pp Melan?	divided brood
39-17	8-17-39	small fg	insectary	fg	fg $\frac{1}{2}$-1, pp	-----	101 Mc	no living pp	
39-19	8-12-39	small fg	insectary	-----	pp	-----	91 Mc	pp unident	
39-33	9-1-39	inc, small fg	in field at insectary	1 inc, high mort -----	log stolen fg $\frac{1}{4}$-$\frac{1}{2}$, 1pp	----- 1 fg	ne emerg. no emerg.	----- no brood	unsuccessful tree
39-34	9-1-39	inc, small fg	field, s. side log field, n. side log insectary	fg $\frac{1}{2}$-1, pp fg $\frac{1}{2}$	fg $\frac{1}{2}$-1, p., NA fg $\frac{1}{4}$-3/4, fg $\frac{1}{4}$-1	bark at insect. no brood -----	 1 emerg.hole 86 Mc	 no brood no brood	
39-37	9-11-39	inc, small fg	field, s. side log field, n. side log insectary	few inc, small fg. few inc, small fg. -----	small fg few none living 1 inc, 3 fg $\frac{1}{4}$-$\frac{1}{2}$	1fg $\frac{1}{2}$ no brood no brood	no emerg. no emerg. no emerg.	no brood no brood no brood	unsuccessful tree
39-38	9-16-39	inc, small fg	field, s. side field, n. side insectary	fg $\frac{1}{4}$-1, pp fg $\frac{1}{4}$-$\frac{1}{2}$ -----	fg$\frac{1}{4}$-1, pp, p all dead fg$\frac{1}{4}$-1	1 pp no brood fg 1, pp, p.	15 Mc ----- emerg.	pp. Melan ----- pp. Melan	divided brood
39-41	9-19-39	inc.	field, sw. side field, n.w. side insectary	small fg small fg -----	2 small fg none alive 1 small fg	2 fg $\frac{1}{4}$-1 none alive fg larval work	no emerg. no emerg. no emerg.	pp. Melan ----- pp. Melan.	divided brood, poor success in this tree
39-42	9-28-39	inc.	field, w. side field, e. side	inc. inc.	fg 0-$\frac{1}{2}$ small fg	2 pp none observ.	1 dead Mc 2 emerg holes	many pp many pp	prepupae overwinter.

* For abbreviations used see Table IIc - footnote

Table II, b Observations on the Development of Overwintering Melanophila californica Broods*

Tree No.	1939 Only Observ.	Spec. Notes	1940 Season * March 3rd wk.	May 2nd wk.	June 4th wk.	Adults&emerg.	Oct.-Nov.	Remarks
39-W-1**	inc, small fg	Butt and lower bole,	inc, small fg	1 small fg	none	none	no brood	poor success
		upper bole.	-----	fg ½-1;pp,p	pp, emerg.	6 Mc	no brood	
39-W-2	small fg	Butt and lower bole	small fg	small fg, inc	pp, emerg.	light Mc	pp. Melan	divided brood
		upper bole,	-----	fg ½-1, pp	adults, emerg.	29 Mc	no brood	
39-W-3	inc	Butt and lower bole,	inc, and small fg	inc, small fg	none	none	pp Melan	prepupae overwinter
		upper bole.	-----	fg 1/3-1, pp	fg 1, pp	none	pp Melan	
39-W-4	small fg	Butt and lower bole,	inc. and small fg	inc, small fg	none no brood	none	no brood 1 pp-Melan	poor success
		upper bole.	-----	fg 1, pp, p	fg ¼-3/4, pp	4 Mc	1 pp. Melan	div. brood
39-W-5	fg ½-1	Butt and lower bole,	small fg	fg ¼-1 pp, p	no emerg. pp	1 Mc	no brood	poor success
		upper bole.	-----	fg ¼-1 pp, p	emerg., 2 p	emerg.	no brood	
39-W-6	-----	Butt s. side of	inc&small fg	inc, small fg	-----	none	-----	prepupae overwinter.
		bole.	-----	fg ½-1 pp, p	pp	1 dead Mc	pp. Melan	
		n. side of bole	-----	inc, small fg	-----	none	pp. Melan	
39-W-7	-----	Butt and lower bole,	-----	inc, small fg	fg ¼-1, pp	none	1 pp. Melan	divided brood
		upper bole.	-----	fg ½-1 pp, p	pp	4 Mc	no brood	
39-W-8	-----	Butt and lower bole,	-----	fg 0-1, pp	no brood	none	no brood	divided brood
		upper bole.	-----	fg ¼-1, pp, p	emerg., pp	17	1 pp. Melan	

* For abbreviations used see Table II c - footnote

** Trees 39-W-1 to 39-W-8 were felled for complete examinations on May 14, 1940

Table II c Observations on the Development of Melanophila californica Brroods*
Development of Brood

Tree No.	Date Felled	Spec. Notes	1939 Only Obser.	March 3rd wk.	May 2nd wk.	June 4th wk.	Adults&emerg.	Oct.-Nov.	Remarks
304	9-26-39	lower bole	inc, small fg	-----	all dead	-----	15 Mc, 1 Mg	no brood	
		upper bole	pp	-----	pp, p	emergence	33 Mc	no brood	
381	3-19-40	lower bole	-----	fg and pp	p	emerg	91 Mc	1 pp	divided
		upper bole	-----	fg, few pp	fg ½-1, pp, p	fg 1, NA, emerg	7 Mc	1 pp Melan	brood
435	9-26-39	lower bole	fg, pp	-----	p, emerg	no brood	128 Mc	no brood	
		upper bole	fg, few pp	-----	fg ½-1 pp, p, NA, emerg	no brood	15 Mc	no brood	
438	10-12-39	lower bole	fg ½-1	-----	fg ¼-1, pp p, NA	no brood	97 Mc	no brood	
947	10-12-39	lower bole	fg, pp	-----	-----	-----	-----	-----	
		upper bole	fg, 0-½	-----	emerg	-----	37 Mc	-----	
1333	10-12-39	mid&lower bole	fg	fg 1, pp	fg, pp	emerg. N.A.	35 Mc	-----	divided
		upper bole	fg , pp	fg 1, pp	fg, pp	-----	80 Mc	1 pp. Melan	brood

* Abbreviations used in designating the developmental stages of the broods are:
inc - incipient larvae
fg - fast-growing larvae
pp - prepupal larva
p - pupa
NA - new adults
emerg - emergence or emerging
overwinter - overwintering or overwintered

Table III. Records of Rearing in Summer of 1940.

Group	Tree No.	Square Feet Bark Reared	Tot. Adults Emerging	Dateeof 1st Emergence	Emergence per Sq.Ft.	Species ° Emerging
A	39-15	12.39	105	6-18-40	8.5	M.c.
B	39-16	10.60	120	6-16-40	11.3	M.c.
B	39-17	8.05	101	6-17-40	12.6	M.c.
A	39-19	7.41	91	6-17-40	12.3	M.c.
	39-33	observation	none	---	--	--
	39-34	15.04	86	5-18-40	5.7	M.c.
C	39-37	observation	none	---	--	--
	39-38	4.30	15	5-15-40	3.5	M.c.
	39-41	observation	none	---	--	--
	39-42	observation	2?	---	--	M.c.?
	39-W-1	6.56	6	6-15-40	.9	M.c.
	39-W-2	6.49	29	6-13-40	4.5	M.c.
	39-W-3	8.78	none	---	none	--
D	39-W-4	5.75	4	6- 9-40	.7	M.c.
	39-W-5	6.33	1	after 6-20-40	.2	M.c.
	39-W-6	observation	none	---	--	--
	39-W-7	1.76	4	6-16-40	2.3	M.c.
	39-W-8	5.01	17	6-14-40	3.4	M.c.
	*101**	11.22	82	5-29-40	7.3	M.c.
	111**	13.60	(82	5-20-40	6.0	M.c.
			(9	5-14-40	.7	M.g.
	116**	13.30	98	5-21-40	7.4	M.c.
	176**	3.56	52	---	14.6	M.c.
	304 upper	8.72	33	5-23-40	3.8	M.c.
	304 lower	7.28	none	---	none	--
	304 midbole	2.98	(approx 20	---	6.7	M.c.
			(1	---	.3	M.g.
E	381 lower	20.41	91	5-18-40	4.5	M.c.
	381 upper	5.74	7	5-28-40	1.2	M.c.
	435 midbole	13.01	(128	5-13-40	9.8	M.c.
			(1	6- 3-40	.01	M.g.
	435 upper	10.49	15	5-13-40	1.4	M.c.
	438	14.23	97	5-21-40	6.8	M.c.
	597**	16.51	54	5-13-40	3.3	M.c.
	947	2.74	39	----	14.2	M.c.
	1333 midbole	14.46	80	5-19-40	5.5	M.c.
	1333 lower	4.64	35	6- 5-40	7.5	M.c.

* Rearing records on trees 101 to 1333 were terminated on June 20, 1940. These emergence figures, therefore, probably are incomplete and less than the actual total emergence from each of the trees for the season.

** The trees double-starred were normal summer brood trees containing prepupal larvae at beginning of autumn 1939. These were reared for comparison with the off-season trees.

° M.c. stands for Melanophila californica, M.g. for Melanophila gentilis.

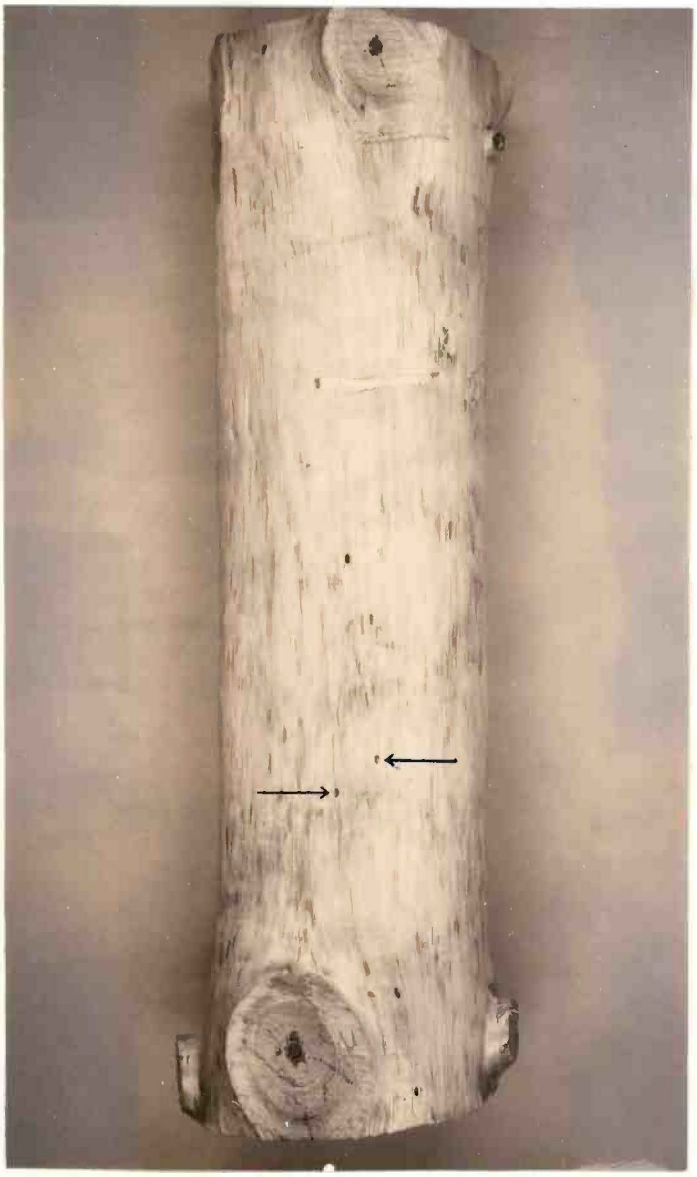

Figure 1

A block from the bole of Tree 39-15. No recent incipient galleries were found on this block, although it contained seventeen pupal cells, of which fifteen produced adults. Eight pupal cells are visible in the photograph, two of which are indicated by arrows.
No. 11473A. Magn.X.40; by J.E.Patterson.

Figure 2

A slab from the bole of Tree 39-15. One recent, short incipient gallery is visible as a faint trace as indicated by the arrows. Several old well-healed galleries are visible also. Five of the six pupal cells yielded adults in the summer of 1940.
No. 11473B. X.70; by J.E.Patterson.

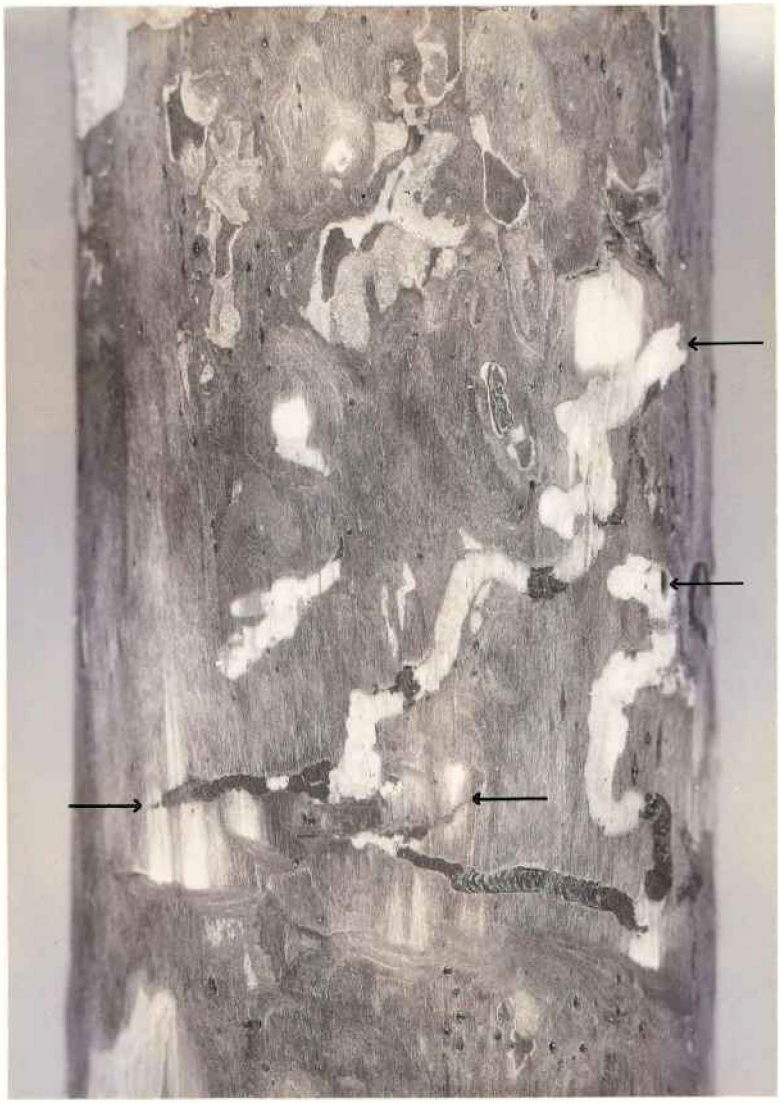

Figure 3

Larval galleries of Melanophila californica Van Dyke in the phloem of Tree 39-15. The two galleries began as streaks in the phloem at the points of entrance of the newly-hatched larvae, as indicated approximately by the lower arrows. The width of the galleries increases with no abrupt changes to maximum width a short distance below the pupal cells, indicated by the arrows at the right. The lower cell produced an adult. The upper cell was still closed and contained a living prepupal larva.
No. 11473C. Magn. X1.2; by J. E. Patterson.

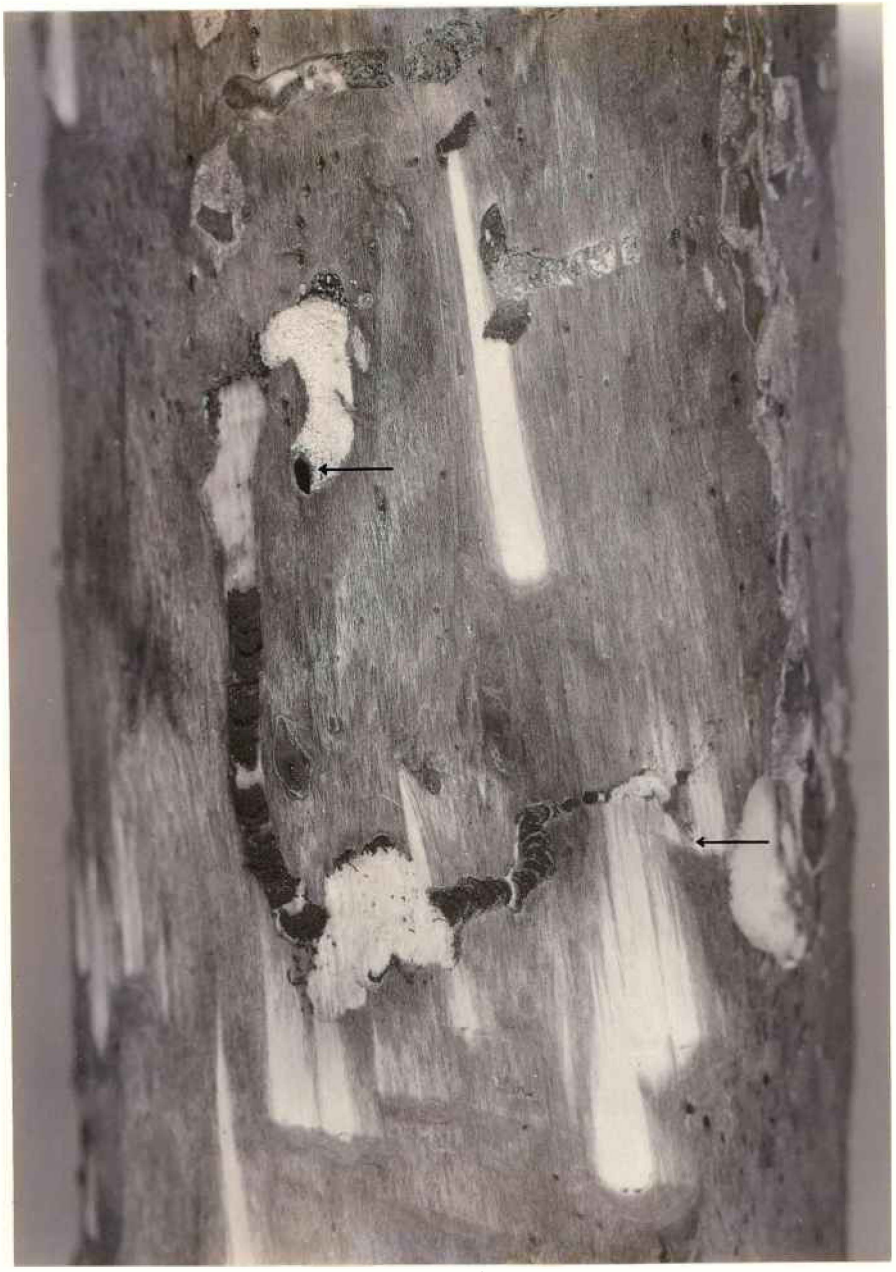

Figure 4

Larval gallery of Melanophila californica Van Dyke in the phloem of Tree 39-15. This gallery began approximately at the point of the arrow at the right. The larva mined a short distance upward to the right, then returned, continuing to the left and finally upward, increasing gradually to full size and pupating in the pupal cell indicated by the upper arrow. An adult beetle emerged from this pupal cell.
No. 11473D. Magn. X1.5; by J. E. Patterson.

Figure 5

A larval gallery of Melanophila californica Van Dyke in the phloem of Tree 39-15. The gallery began approximately at the point of the upper arrow. (The phloem streak unfortunately was peeled off in exposing the gallery where it reached the sapwood). The gallery increases gradually in width. Pupation probably took place in one of the two pupal cells at the lower left. These produced adults later in the season.
No. 114736. Magn. X1.4; by J. E. Patterson.